AMOUNT, CAUSE *and* ECONOMIC IMPORTANCE *of*-

CRACKED EGGS

TO OHIO POULTRY INDUSTRY

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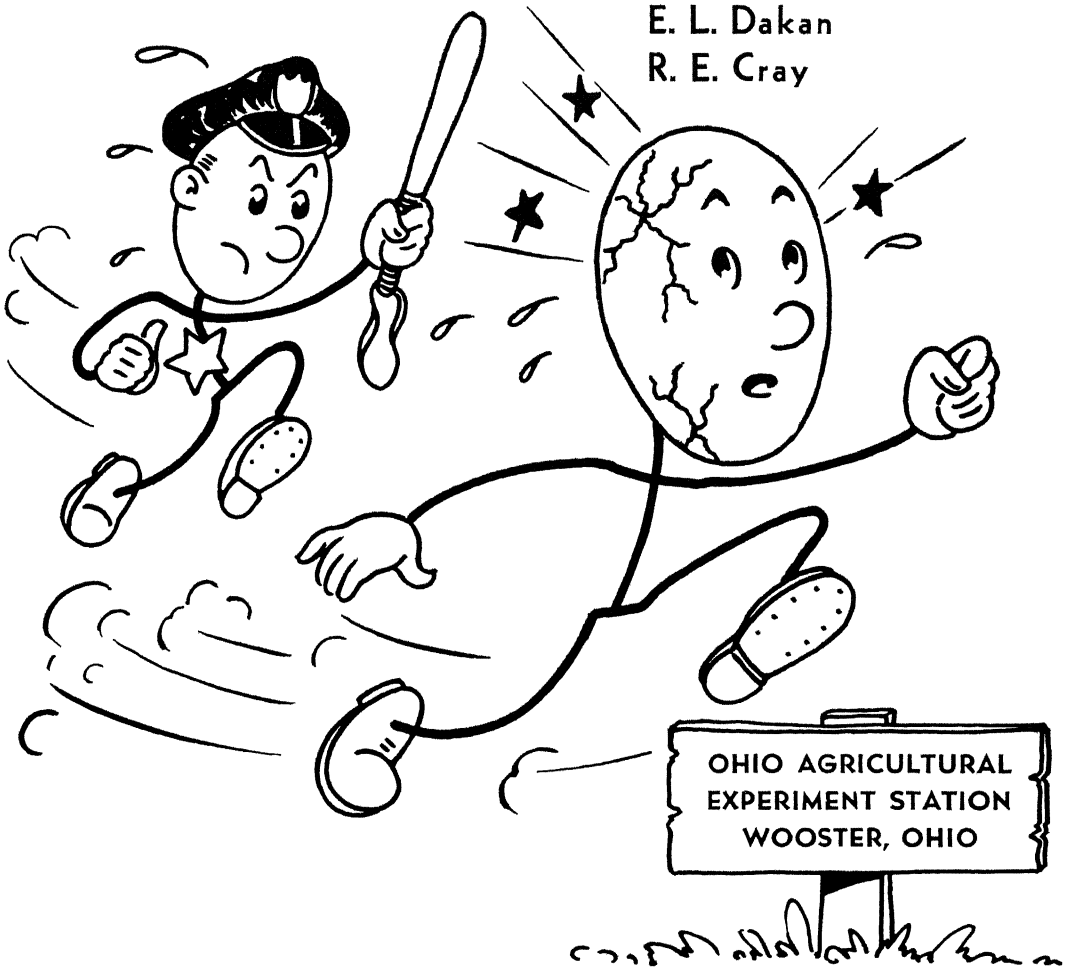

CONTENTS

FOOTNOTE

This study analyzes the seriousness of the problem of cracked eggs on the farm and in marketing channels but does not make a comprehensive attempt to reveal the cause of the breakage.

The seriousness of the problem indicates the urgency of the need of further study designed to reveal the causes of egg breakage and their control.

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Losses from cracked* or broken eggs are of serious concern, not only to the producers but also to all of the marketing agencies between the producers and consumers. These losses are of concern because they occur in every phase of the marketing procedure and are measured in terms of millions of dollars every year.

A study** of producers' reaction to the practice of selling eggs on a graded basis shows that approximately one-fifth of the producers who were dissatisfied complained because there were too many cracked eggs for which they were paid at a much lower rate per dozen.

Every marketing agency finds that a sizable percent of the eggs they buy must be sold at a reduced price as checked or cracked eggs.

Purpose and Organization of the Study

This study was made to determine the extent of damage to eggs by cracking on the farm and in the various stages of the marketing process and where possible, to evaluate the influence of practices in the production and marketing of eggs on the extent of this loss, and finally, to estimate on the basis of these data the annual loss to the industry in Ohio due to cracked eggs.

Data on the average percent of eggs cracked on the farm and the management practices followed were secured from 80 producers who were selling eggs on a graded basis to buyers operating under Federal-State grading supervision. These producers were located in Delaware, Franklin, Pickaway, Perry, Hocking, Athens and Meigs counties in Ohio.

Data on the seasonal and yearly variations in the average percent of eggs cracked when they reached the grading station and the average percent of eggs cracked after grading were secured from the records of grading stations operating under Federal-State supervision.

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* "Cracked Eggs" for the purpose of this study included all broken, cracked and "checked" eggs, regardless of whether the eggs were leaking or not.

** Ohio Agricultural Experiment Station bulletin #693 "Marketing Eggs on a Graded basis in Ohio."

Tests were also conducted at two grading stations to determine the average percent of eggs cracked in the various plant operations and to compare the average percent of eggs cracked by hand grading and machine grading.

A check was made of the average percent of cracked eggs found by the Federal-State inspectors in the eggs which were graded and ready for shipment to wholesalers. Studies have already been made showing the average percent of eggs cracked while being shipped from the first receiver to the wholesaler.

I. WHERE ARE EGGS CRACKED?

This study gives a picture of the amount of breakage occurring in eggs on the farm and in each step of the marketing process from the producer to the retailer.

A. Eggs Cracked on the Farm

Losses, due to eggs being cracked on the farm and in the different marketing operations, are of real concern to the producers because they involve a reduced price on a sizable percent of eggs in addition to the complete loss involved when the shells are broken badly enough to cause leakage.

Eighty producers were interviewed during January 1948 to determine the number of cracked eggs removed by the producer before the eggs were sold. Each producer was asked these four questions:

1. How many cracked eggs did you remove from the eggs you gathered yesterday?
2. How many cracked eggs did you remove from the eggs you gathered the day before yesterday?
3. Was this about the average number of cracked eggs removed each day from the eggs you gathered during the past week?
4. What was the average number of eggs gathered each day during the past week?

On the basis of this information an estimate was made of the percentage of cracked eggs removed by the producer before the eggs left the farm.

Since the eggs were not candled on the farm, the producer could only remove the eggs that were obviously damaged, undoubtedly missing many cracked eggs which showed up later when the eggs were candled.

Producers interviewed in this survey reported that an average of 2.8 percent of cracked eggs were removed from all the eggs gathered on the farm. The percent of cracked eggs found by the individual producers ranged from 0.1 percent to 10 percent of all eggs gathered. This means that an average of ten eggs per case were found cracked or broken in

the nest, or cracked in gathering and removed before the eggs were sent to market.

The percent of cracked eggs found on the farm was undoubtedly influenced by the thoroughness of the examination when they were packed, brightness of the light and sharpness of the eyesight of the packer.

Eggs from 61 of these producers were checked carefully when they arrived at the grading station to determine whether there was any relationship between the percent of cracked eggs removed by the producer at the farm and the percent of cracked eggs upon arrival at the grading station.

TABLE 1.—Relation of average percent of cracked eggs removed at the farm to average percent of crecked eggs found at the grading station.

Number of flocks	Av. percent of cracked eggs removed at the farm	Av. percent of cracked eggs found at grading station
6	Less than 1%	1.55%
20	1% to 1.9%	2.39%
20	2% to 2.9%	2.09%
15	3% to 6%	1.84%
61	2.8%	2.07%

Producers finding less than one percent cracked eggs on the farm also had the smallest average percent of cracked eggs at the receiving station. With the other groups of producers, it was found that as the average percent of cracked eggs removed at the farm increased, the average percent of cracked eggs found at the grading station decreased.

B. Eggs Cracked on Arrival at Grading Station

Even a careful examination of the exterior of eggs when they are packed on the farm fails to reveal some cracked eggs that show up when placed before the candling light at the grading plant. In addition, some eggs are probably cracked in packing and transporting to the grading station.

1. **Variation in percent of cracked eggs found at grading stations over a period of 17 years.**

A summary of the annual reports of the Federal-State Egg Grading Service in Ohio, over a period of 17 years from 1932 to 1948, fails to show any definite trend of change in the average yearly percent of cracked eggs found in eggs purchased from producers on a graded basis, but for the entire period averaged 2.9 percent of all eggs received.

There is no obvious explanation for the variation in the average yearly percent of cracked eggs found by the grading stations operating under Federal-State supervision, but the records do indicate the seriousness of the loss over a period of years. (Chart 1, P. 6, Table 2, P. 7) studied. (Chart 2, P. 8)

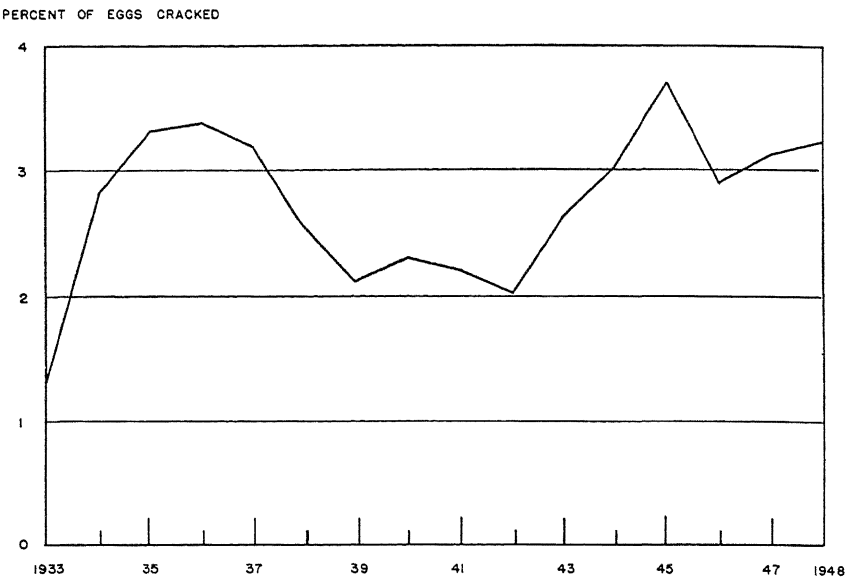

CHART 1.—Annual Average Percent of Cracked Eggs Found by Federal-State Grading Service at Grading Stations Buying Eggs Direct from Producers in Ohio During 1932-48.

Source: Federal-State Grading Service Annual Reports.

2. Seasonal variation in percent of cracked eggs.

Seasonal variations in percentage of eggs found to be cracked upon arrival at the eight grading stations buying from producers on the basis of official grades, reached a peak in July during each of the three years of 1946 to 1948.

All eight grading stations showed the same seasonal trend in percentage of cracked eggs but there was considerable difference in the percentage of cracked eggs found at all times of the year by the different grading stations.

The seasonal variation in average percent of cracked eggs experienced in Grading Station 2, which had the highest percent, and Grading Station 3, which was one of the stations with a low percent of cracked eggs when compared graphically, showed that there was only one month in which Grading Station 3 had a higher percent of cracked eggs than Grading Station 2. There were only seven months when Grading Station 2 had fewer cracked eggs than the average of all eight grading stations studied. (Chart 2, P. 8)

TABLE 2.—Annual average percent of cracked eggs found by Federal-State Egg Grading Service at Grading stations buying eggs direct from producers in Ohio during 1932-48.

Year	Total Volume of Eggs Graded in Ohio under Federal-State supervision . (cases)	Average yearly percent of cracked eggs. (percent)
1932	9,000	1.1%
1933	58,886	1.1
1934	120,455	2.8
1935	143,138	3.3
1936	172,714	3.4
1937	259,285	3.2
1938	324,952	2.5
1939	355,484	2.1
1940	391,321	2.3
1941	447,634	2.2
1942	696,098	2.0
1943	746,055	2.6
1944	841,866	3.0
1945	754,504	4.7
1946	967,846	2.9
1947	1,068,698	3.1
1948	1,229,405	3.2
	8,587,341	Average 2.9%

Average seasonal variations in percent of cracked eggs found at the eight grading stations ranged from a low of approximately 2 percent in November, December and January to a high of approximately 3.3 percent in June, July and August. This is clearly explained by the difference in season temperature which has already been shown to have a very direct bearing on the thickness of egg shells.*

3. Variation in percent of cracked eggs found at different grading stations during 1948.

An analysis of the annual report on the Ohio Federal-State egg grading service shows that an average of 2.6 percent cracked eggs were removed from the 540,575 cases of eggs purchased direct from producers by nine grading stations during 1948.

The variation in annual percent of cracked eggs found by the different individual grading stations ranged from 1.6 percent to 3.3 percent of all eggs graded (Table 3).

There is no obvious explanation for this wide variation in percent of cracked eggs found at the various grading stations but it does mean a substantial difference in the annual income per hen for the producer.

C. Eggs Cracked in the Grading Station

The process of candling, grading and repackaging in the plant also takes its toll in cracked eggs. The supervisor of the Federal-State

* The effect of air temperatures on egg shell thickness in the fowl. P. Sci.: 19, 67, 1940.

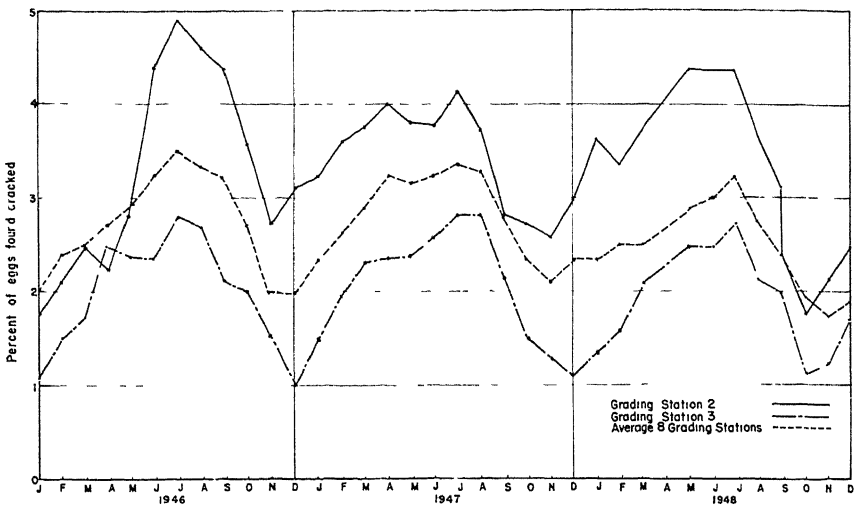

CHART 2.—This shows the percentage of cracked eggs found at the station with the lowest percentage, the highest percentage and the average for all eight grading stations. The seasonal variation indicated is based on approximately 500,000 cases of eggs graded annually by the Ohio Federal-State Grading Service during 1946-48.

grading service at the plant is responsible for recandling samples of graded eggs to check the accuracy of the candling and sizing before the eggs leave the plant. Actual reports from the inspectors of seven grading stations were summarized for the period from January 1, 1948 to July 1, 1948 and then tabulated (Table 4).

TABLE 3.—Average yearly percent of cracked eggs found in eggs purchased direct from producers by nine Federal-State grading stations during 1948.

Grading Station	Number of cases of eggs purchased direct from producers on graded basis (number)	Average percent of cracked eggs found (percent)
1	44,443	3.3%
2	106,122	2.2
3	56,746	1.9
4	39,044	3.1
5	39,238	1.6
6	7,724	2.4
7	57,955	3.1
8	173,209	2.8
9	16,094	1.6
Total and average	540,575	2.6%

TABLE 4.—Cracked eggs found in graded eggs packed under Federal-State supervision when eggs were inspected by supervisors at seven different grading stations during period, Jan. 1 to July 1, 1948. *

Grading Station	Eggs Inspected (cases)	Percent of Eggs Found Cracked when Eggs were Inspected After Grading
1	148	2.94
2	22	2.59
3	158	3.34
4	157	1.87
5	213	3.28
6	188	1.94
7	138	1.59
Total and average	1024	2.54%

All cracked eggs were to have been removed by the graders as the eggs were candled for quality. Hence, the eggs found by the inspectors when checking the grading should have been eggs that were cracked during the grading and repackaging operations.

Egg breakage occuring in grading plants was further studied by checking the number of cracked eggs in two cases of eggs at one plant and four cases at another plant before grading and rechecking the same cases after grading.

In this test the percentage of eggs cracked varied from .28 percent in one case to 4.16 percent in another with an average for the six cases of 1.99 percent (Table 5).

D. Eggs Cracked Between Grading Station and Wholesaler

In May and August of 1948, as the Ohio part of a regional egg marketing study, eggs were graded when received at the plants of several types of first receivers. The same eggs were later graded when they reached the wholesale outlets in the terminal markets.

An analysis of data secured in this test showed that an average of .92 percent of the eggs were cracked between the first receiver and the wholesale outlet.

TABLE 5.—Variation in percent of eggs cracked in the grading operation.

Grading Station	Lot Number	No. of eggs in the test	No. of eggs cracked	Percent of eggs cracked
2	1	360	6	1.66
2	2	360	15	4.16
3	3	360	6	1.66
3	4	360	7	1.94
3	5	360	8	2.22
3	6	360	1	.28
Total		2160	43	Aver. 1.99%

* Source: Federal-State Grading Supervisors' Weekly Reports.

TABLE 6.—Relation of number of times eggs were gathered each day on the farm to the average percent of cracked eggs found at the grading station.

Number of times eggs were gathered each day	Number of flocks (number)	Percent of flocks (percent)	Percent of cracked or broken eggs found at the grading station
Once a day	12	15.0%	3.3%
Twice a day	27	33.8	2.6
Three times a day	27	33.8	2.6
Four times a day	11	13.8	2.3
Five times a day	3	3.8	2.1
Total	80	100.0%	Aver. 2.8%

These data cover both graded and "current receipt" eggs. The distance from first receiver to the wholesaler ranged from 12 miles to 200 miles.

II. HOW AND WHY EGGS ARE CRACKED

Since losses from cracked eggs have been broken down into the occurrence on the farm and at each step of the marketing process it is important to determine the cause of the losses in each step.

A. Cause of Egg Breakage on the Farm

The 80 producers originally interviewed in the study were also asked a number of questions about their management practices in an effort to determine if any relationship existed between the practices and the percent of cracked eggs found on the farm or at the grading station.

1. Effect of frequency of gathering on percent of cracked eggs found at the grading station.

Producers gathering eggs only once a day had an average of at least 1 percent more cracked eggs at the grading station than producers who gathered their eggs four or five times a day (Table 6).

As the number of times producers gathered eggs each day increased, the average percent of cracked eggs removed at the grading station decreased.

TABLE 7.—Percent of cracked eggs found on inspection of 1024 cases by Federal-State supervisors in seven grading stations during 1948.

Grading Station	Percentage of Eggs Cracked	
	White Eggs	Brown Eggs
1	2.94%	3.00%
2	3.42	1.50
3	3.39	3.93
4	1.92	1.74
5	3.48	2.72
6	1.89	2.14
7	1.67	1.47
Average percent of eggs cracked	2.55	2.42

2. Effect of shell color on breakage

In each grading station where the grading is under Federal-State supervision it is the responsibility of the inspector to check a small percent of the eggs to see that they are graded accurately.

Weekly reports of these inspectors at seven grading stations were summarized in 1918 to determine if there was any difference in the percent of cracked eggs found in the white and brown eggs.

TABLE 8.—The relation of some management practices folowed on the farm to the percentage of cracked eggs removed at the farm.

Management Practices Followed on Farm		Percent of cracked Eggs Removed at the Farm
Breed of chickens	New Hampshire	3.2%
	White Rock	3.1
	Mixed and two breeds	2.6
	S.C. White Leghorn	2.5
Percent of pullets in laying flock	100% pullets	2.9%
	75-99% pullets	2.8
	50-74% pullets	2.2
	0-49% pullets	2.3
Quality of chicks from which laying flock was grown	Flocks grown from Standard Grade of chicks	1.9%
	Flocks grown from Top Grade chicks	2.9
Time laying flock was hatched	Hatched before March 15	2.5%
	Hatched after March 15	2.7
Method of feeding oyster shell	Free choice in hoppers only	2.8%
	Free choice in hoppers and also mixed in mash	2.0
Effect of feeding grit	Grit fed	2.5
	No grit fed	2.7%
Number of nests per 100 layers	Less than 10 nests	2.7%
	10 to 19 nests	3.0
	20 or more nests	2.1
Type of material in nests	Straw	2.6%
	Shavings	2.9
	Other	2.3
Type of container used for gathering eggs	Wire basket	2.8%
	Feed pail	2.7
	Split wood basket	2.2
Method of cleaning eggs	Washed in water	3.6%
	Emery cloth brush, hand operated	2.6
	Emery cloth, electric cleaner	1.6

These data indicate little if any difference in the amount of breakage in white and brown eggs (Table 7).

3. Effect of several management practices on breakage.

Several other management practices followed on the farm were tabulated in relation to the egg breakage experienced. The resulting information is tabulated in Table No. 8.

This study indicated that more cracked eggs were found on the farms that had New Hampshires and White Rocks than on the farms that had Single Comb White Leghorns. It also indicated that the flocks with the higher percentage of pullets experienced a larger amount of egg breakage which is contrary to other research studies made on this specific problem.

The time the laying flock was hatched, the number of nests supplied per 100 layers and the type of nest material used, all seem to have very little if any effect on breakage.

Less egg breakage was experienced by the producers using split wood baskets than those using wire baskets and feed pails for gathering eggs. Likewise more breakage was experienced by those washing eggs in water than by those using the hand emery cloth brush or the electric cleaners.

Feeding oyster shell in the mash as well as in the hopper reduced egg breakage but grit apparently had little effect.

B. Cause of Egg Breakage in the Grading Plant

The necessary physical handling of eggs in the grading plant in candling for quality, grading for size and repackaging always results in some breakage.

1. The effect of size of eggs on percentage cracked

It is generally agreed by egg marketing men that the breakage of Extra Large or Jumbo eggs is greater than normal sized eggs. Eggs graded for size and carefully checked to eliminate all cracked eggs were divided into three groups and each group sent to a different grading station.

The percentage of Jumbo eggs cracked at the two grading stations where 360 Jumbo eggs had been packed in each case was much more serious than with the other sizes of eggs. At Station 2 where the Jumbo eggs were packed in a Jumbo case with Jumbo fillers holding only 180 eggs to the case, the average breakage was less than with any of the samples checked regardless of size.

The percentage of cracked eggs found in the different sized eggs was in direct relationship—the larger the egg, the larger the percentage broken.

TABLE 9.—Effect of egg size on the percent of eggs cracked in the grading plant.

Size of Eggs	Total Number Eggs in Test	Percent of Cracked Eggs Found After Grading			
		Grading Sta. #1	Grading Sta. #2	Grading Sta. #3	Average of all Grading Stations
Jumbo	1260	4.0%	1.1%*	6.4%	3.8%
Large	6480	3.1	4.5	2.5	3.3
Medium	2520	2.6	3.3	3.5	3.2
Small	1800	2.6	1.4	—	2.1
Total and Aver.	12,240	3.1%	3.7%	3.3%	3.3%

* Packed in Jumbo case and fillers.

This test indicates the importance of selecting out the Jumbo eggs on the farm and either using them for home consumption or packing them in larger fillers designed especially for Jumbo eggs.

2. Eggs cracked by grading machine

The Federal-State grading supervisor in three plants kept separate records on the number of cracked eggs found in the eggs size-graded by machines and the eggs size-graded by hand.

In this comparison an average of 3.1 percent cracked eggs were found in the machine size-graded eggs and an average of 3.9 percent of cracked eggs in the hand size-graded eggs.

This study would indicate that size-grading machines, properly adjusted, do not crack any more eggs than when the eggs are size-graded by hand.

Results of this test are further substantiated by the percentage of cracked eggs found by Federal-State inspectors at three different grading plants over a period of six months. All eggs at Grading Station 6 were machine size-graded and contained an average of 1.94 cracks over the six-months period. All the eggs at Grading Station 4 were hand size-graded and during the same period contained 1.87 cracks.

TABLE 10.—Comparison of percent of eggs cracked in machine size grading and hand size grading.

Eggs Size Graded by Machine				Eggs Size Graded by Hand		
Grading Station	Total No. Eggs	No. Eggs Cracked	Percent of Eggs cracked	Total No. Eggs	No. Eggs Cracked	Percent eggs Cracked
1	3960	120	3.0%	1080	39	3.6%
2	3960	149	3.8	360	13	3.6
3	2880	95	3.3	720	33	4.6
Tot. & Ave.	10,800	364	3.4%	2160	85	3.9%

At Grading Station 7 part of the eggs were size-graded by machine and part were size-graded by hand and this plant averaged 1.54 cracked eggs during the six-months period. The incidence of cracked eggs with machine and hand size-grading operations was further studied in one grading station, where records were available, on the percentage of cracked eggs found when all grading was done by hand; the percentage cracked while machines were being installed and one-half of the size-grading was done by hand and the other half by machine and then finally; the percentage cracked during the third period when all the eggs were size-graded on the machine.

During the period when all of the eggs were hand size-graded an average of 2.4 percent were cracked in the grading process. During the period of conversion when part of the eggs were hand size-graded and part machine size-graded, an average of 3.2 percent of the eggs were cracked in the grading operation. After the grading plant was entirely converted to machine size-grading, an average of 2.6 percent of the eggs were cracked in the operation. It must be remembered, however, that this was during the period of early experience with the grading machine.

In an effort to determine just where the breakage occurs on an egg-grading machine, a test was made in which some of the eggs, after grading, were allowed to roll down on the receiving trays and hit each other. The amount of breakage resulting from this method was compared with the amount resulting when eggs were picked off receiving trays before they contacted other eggs.

The average percentage of eggs cracked under these conditions was somewhat higher when the eggs were allowed to roll down the trays and contact other eggs.

Unquestionably the percentage of eggs cracked on the trays is much higher if the slope of the trays is not properly adjusted. If the slope of the tray is too high the speed of the eggs rolling down the tray is too great and damage is more likely to occur.

TABLE 11.—The percent of eggs cracked when eggs were allowed to roll down and contact other eggs on trays of grading machines compared to percent cracked when eggs were removed from trays before they could contact other eggs.

Method of Handling Eggs on Grade Trays of the Grading Machine	Total No. of Eggs in the Test	No. of eggs cracked in the test	Percent of eggs cracked in the test
Eggs allowed to roll down tray and contact other eggs	720	13	1.81%
Eggs picked off tray to prevent contacting other eggs	720	9	1.25%

3. Eggs cracked in repacking after grading

In order to determine in which part of the case the most breakage occurs, a total of 11 cases of graded eggs were carefully checked to determine the number of cracked eggs in each filler.

TABLE 12.—The percent of cracked eggs found in the different fillers in the cases of of eggs that had been graded and repacked under Federal-State supervision at three grading stations.

Position of filler in the case	Total No. of Eggs in the Test	Number of cracked eggs: End of case packed first	End of case packed last	Entire Case	Percent of eggs that were cracked	Percent of all cracked eggs
Top Filler	2952	37	52	89	3.01%	17.84%
Filler next to top	2952	41	30	71	2.41	14.23
Middle Filler	2592	38	45	83	2.81	16.63
Filler next to bottom	2952	69	60	129	4.37	25.85
Bottom Filler	2952	65	62	127	4.30	25.45
Total	14,760	250	249	499	3.38%	100.00%

The two lower layers or fillers in the cases contained the highest percentage of cracked eggs. The exact cause for the higher percentage of cracked eggs in the lower fillers was not accurately determined but it may be that the packer, reaching down further into the case, exerted greater pressure on the eggs or dropped them a little farther. The packer was also under greater pressure for time when packing the bottom fillers because of the accumulation of eggs on the packing trays while the cases were being changed or turned.

4. Graded eggs cracked on conveyors in grading station

Tests were set up in two of the grading stations to determine the number of eggs cracked from the pressure on the cases when they were shoved down the conveyor lines or when the cases were bumped by other cases on the conveyors.

In this test, Grade A large white eggs were packed in two used fibre cases of poor condition, one case (Case A) was placed on the conveyor line behind three full cases of eggs. The other used fibre case (Case B) was placed on the same conveyor line with an empty space of six feet between Case A and Case B. Then three cases of eggs were placed on the conveyor line behind Case B. All four cases in each of the two groups were placed lengthwise on the conveyor line.

Sufficient force was then exerted on the second group of four cases of eggs to drive them into the first group and to push both groups ten feet down the conveyor line. In the opinion of the plant officials, the shock which resulted from the impact was as great as ever occurred in the normal operations of the plant.

The eggs were then recandled and four cracked eggs were found in the case of eggs which was bumped (Case A) and nine cracked eggs were found in the case of eggs (Case B) that was pushed by the other group.

The position of the cracked eggs in the case was carefully tabulated but no relationship was found between the position of the cracked eggs and the end of the case on which the impact occurred. The same type of test was conducted in another grading plant and in this test, 13 cracked eggs were found in each of the two cases involved in the impact and, like the first test, there was no consistent pattern to the distribution of the cracked eggs in the two cases.

It would appear from these studies that the greater part of the physical damage to eggs in the grading plant occurs at the time the eggs are graded and repacked into the cases. A small percentage of eggs are also cracked in accidents in handling of eggs; in lifting fillers from the eggs and in the physical movement of eggs in the plant.

III. THE ECONOMIC SIGNIFICANCE OF CRACKED EGGS TO THE INDUSTRY

The average percent of eggs cracked in each phase of the marketing operation, while serious, does not show the real size of the problem. The real seriousness of the problem becomes apparent when these losses are combined.

TABLE 13.—Average percent of eggs cracked before reaching the wholesaler.

Occurrence of Breakage	Average Percent of Egg Cracked
A. Eggs cracked and removed at the farm	2.8%
B. Eggs cracked and removed at time of grading	2.6
C. Eggs cracked in grading station	2.5
D. Eggs cracked between grading station and wholesaler	.9
Total	8.8%

Obviously the producer must absorb this loss because prices and margins at each step of the marketing procedure are established to absorb the share of the loss occurring at that point.

These data show that an average of approximately one egg out of each dozen, or 31.7 eggs out of each case, must be sold as cracked eggs at a substantial reduction in price. The true size of this loss becomes apparent only when it is realized that approximately 6,320,000 cases of eggs were sold from Ohio farms in 1948.

In order to get an accurate estimate of the average decrease in value of eggs when they are cracked, the weighted average price of all eggs was compared with the average price of cracked eggs at two grading stations during the first week of each quarter in the fiscal year 1947-48.

TABLE 14.—Comparison of average weighted price of all eggs other than cracked eggs and average price of cracked eggs at two grading stations during the first week of each quarter during the fiscal year, 1947-48.

	Grading Station 1				Grading Station 2			
	All Eggs Other Than Cracked Eggs		Cracked Eggs		All Eggs Other Than Cracked Eggs		Cracked Eggs	
First week each quarter (date)	Vol. sold (cases)	Av. wght'd. price (per doz.)	Vol. sold (cases)	Av. price (per doz.)	Vol. sold (cases)	Av. wght'd. price (per doz.)	Vol. sold (cases)	Av. price (per doz.)
10/3/47	1939	57c	39	33c	1521	59c	34	33c
1/3/48	2784	53c	50	37c	1880	54c	15	40c
4/3/48	1724	49c	36	36c	2198	50c	42	40c
7/1/48	1637	53c	51	36c	1846	55c	41	38c
Total or ave.	8084	53.1c	175	35.6c	7445	54.1c	132	37.5c
Difference in average price per dozen of all eggs other than cracked eggs and the average price of cracked eggs					17.5c		17.6c	

These data indicate that cracked eggs brought the producer an average of approximately 17.5 cents per dozen less than the weighted average price received for all other grades of eggs.

Based on an average of 8.8 percent of the eggs being cracked by the time they reached the wholesaler, and a decrease in value of 17.5 cents per dozen due to cracking, the reduction in the value of eggs due to cracking was 46.2 cents per case.

According to the U. S. Department of Agriculture, approximately 6,320,000 cases of eggs were sold from Ohio farms during 1948. On the basis of this volume and a potential loss in value of 46.2 cents per case due to cracked eggs, the total potential loss to the Ohio poultry industry was approximately $2,919,840. in 1948.

TABLE 15.—Summary of losses to the poultry industry of Ohio from cracked eggs during 1948.

Average total percent of cracked eggs removed from farm to wholesaler	8.8
Average total number cracked eggs removed per case from farm to wholesaler	31.7
Average reduction in value of cracked eggs compared with all other eggs	17.5c per dozen
Average loss from cracked eggs per case	46.2c
Average loss from cracked eggs per 1,000 cases	$462.00
Annual sales of eggs from Ohio farms during 1948 (30 doz. cases)	6,320,000
Annual loss to Ohio due to cracked eggs on the sale of 6,320,000 cases of eggs	$2,919,840.00

It is well to remember that this study does not include the breakage of eggs occurring between the wholesaler, the retailer and the consumer. Since many eggs are sold directly to consumers or retailers by the farmer, the estimated loss resulting from breakage probably represents a conservative appraisal of the economic seriousness of the problem.

SUMMARY

1. Eighty producers in Central Ohio were interviewed to determine the average percent of cracked eggs found and removed at the farm and the management methods practiced.

2. The 80 producers removed an average of 10 cracked eggs per case of eggs at the farm or an average of 2.8 percent of all eggs sold.

3. Producers who reported finding less than 1 percent cracked eggs on the farm also had the smallest percent of cracked eggs at the receiving station. With the other groups of producers, it was found that as the average percent of cracked eggs removed at the farm increased, the average percent of cracked eggs at the grading station decreased.

4. The annual average percent of cracked eggs found by Federal-State egg grading inspectors at grading stations buying eggs direct from producers in Ohio during the period of 1932 through 1948, ranged from 1.1 percent to 4.7 percent of all eggs bought but does not show any definite trend or change in the average annual percent of cracked eggs.

5. Average seasonal variation in cracked eggs found at eight grading stations over a three-year period, 1946-1948, ranged from a low of approximately 2 percent in November, December and January to a high of approximately 3.2 percent in June, July and August.

6. The annual report of the Ohio Federal-State Grading Service for 1948 shows that the average percent of cracked eggs removed by nine different grading stations ranged from 1.6 percent to 3.3 percent of all eggs purchased. An average of 2.6 percent of cracked eggs were removed from 540,575 cases of eggs purchased direct from producers by these nine grading stations during 1948.

7. Weekly reports of the Federal-State egg grading inspectors at seven grading stations during the period January 1, 1948 to July 1, 1948, showed that an average of 2.54 percent of the eggs inspected were cracked during candling or size-grading and repackaging.

8. As part of a regional project, Ohio found that the same eggs, graded first at the receiving station and then later at the wholesale outlet in the terminal market, showed an increase of .93 percent cracked eggs between the receiving station and the wholesaler.

9. Comparison of reports of Federal-State egg grading inspectors failed to show any appreciable difference in the percentage of cracked eggs found in white and brown eggs.

10. With each increase in the number of times the eggs were gathered each day by the 80 producers, there was a decrease in the percent of cracked eggs found at the grading station.

11. The month the laying flock was hatched, the number of nests per 100 layers and the type of material used in the nests showed little effect on the egg breakage experienced by the 80 producers.

12. Less egg breakage was experienced in gathering the eggs by producers using split wood baskets than by those using wire baskets or feed pails to gather the eggs.

13. Feeding oyster shell in the mash as well as in the hoppers reduced egg breakage.

14. Fewer eggs were cracked when they were cleaned with an electric emery cloth cleaner than when cleaned by a hand emery brush and substantially more eggs were cracked when they were washed with water than by either of the above methods.

15. The percent of cracked eggs found after grading showed a definite relationship to the size of the eggs—as the size decreased the percent of cracked eggs decreased.

16. The percent of eggs cracked where the eggs were size-graded by machines was no larger than where eggs were size-graded by hand.

17. The percent of eggs cracked on sizing machines when eggs were allowed to roll down and contact other eggs on the grading trays was larger than when the eggs were removed from the trays before they contacted other eggs.

18. An examination of graded eggs showed that the two lower layers or fillers in the cases contained the highest percent of cracked eggs.

19. Tests showed that very few eggs were cracked by the cases bumping against each other on the conveyor.

20. An average of 8.8 percent of the eggs were cracked from the time they were laid on the farm until they reached the wholesaler in the terminal market. This represents a loss of approximately one cracked egg in each dozen or 31.7 cracked eggs in each case sold.

21. A comparison of the weighted average price of eggs other than cracked eggs with the average price of cracked eggs at two grading stations during the first week of each quarter of the fiscal year of 1947-1948, showed an average difference of 17.5 cents per dozen.

22. According to a report of the Bureau of Agricultural Economics, Ohio sold approximately 6,320,000 cases of eggs during 1948. The total loss due to cracked eggs in Ohio during 1948, based on the above figures, amounted to $2,919,840.

REFERENCES

1. Berg, Lawrence R. (1949). Improving Shell Strength. Pacific Poultryman 53 (2).

2. Dawson, L. E. and Davidson, J. A. Producing Quality Eggs. Mimeo. Michigan Agricultural Extension Service.

3. Heuser, G. F. and Norris, L. C., 1946. Oyster shells, calcite grit, ground limestone and granite grit in rations for hens. Poultry Sci. 25 (2).

4. Kennard, D. C., 1925. Sources of Lime for Egg Shells. Ohio Agr. Exp. Sta. Bimo. Bul. 10, No. 7.

5. Kennard, D. C. 1925. Essential Minerals for chicks and laying hens. Poultry Sci. 4: 109-117.

6. Kennard, D. C. and Chamberlin, W. D. Thin egg shell, their causes and remedies. Ohio Agr. Exp. Sta. Bimo. 225 (1943).

7. Kennard, D. C. A device for testing the breaking strength of shell eggs. U. S. Egg and Poultry Review. May 1945.

8. Morgan, C. L. (1932). Relationship between breaking strength and the percent of egg shell. Poultry Sci. 11: 172-175.

9. Munro, S. S. (1938). Effect of heredity on interior egg quality and shell composition. Poultry Sci. 17: 17-27. Ibid. (1940). The relation of specific gravity to hatching power in eggs of the domestic fowl. Sci. Agr. 21: 53-62.

10. Quinn, Joseph P., Gordon, Clement and Godfrey, Albert B. (1945). Breeding for Egg Shell Quality as indicated by egg weight loss. Poultry Sci. 24: 403.

11. Romanoff and Romanoff (1949). The Avian Egg. John Wiley and Sons. P. 374.

12. Stewart, H. O. and Hart, C. P. 1938. The effect of different calcium intake levels on egg production, shell strength, and hatchability. Poultry Sci. 17: 3-7.

13. Taylor, L. W. and Lerner Michael. 1939. Inheritance of egg shell thickness in White Leghorn Pullets.

14. Van Wagenen, Alfred. Let's produce "AA" quality eggs. Agr. Ext. Service, Ohio State University. 1945.

15. Wilhelm, L. A. Some factors affecting variations in egg shell quality. Poultry Sci. 19. 1940 No. 4.